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CLAIMS

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[Claim(s)]

[Claim 1] The washing method of the semiconductor device characterized by irradiating an ultrasonic wave with a horizontal component and a vertical component to the hole and slot which were formed in the semiconductor wafer, vibrating a liquid molecule, and washing.

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[Translation done.]

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application] Especially this invention relates to the washing method of a semiconductor device that the foreign matter adhering to the hole formed in the semiconductor wafer or Mizouchi is removable, about the washing method of a semiconductor device.

[0002]

[Description of the Prior Art] the structure of the circuit which detailed-ization of a semiconductor device, for example, a semiconductor integrated circuit, progresses recently, and is formed in the front face of a semiconductor wafer -- complicated -- becoming -- a front face -- \*\*\*\* -- a convex is becoming intense For this reason, it remains along with the wall surface after the pars intermedia near the opening of the trench hole 3 where the foreign matter 1 was formed in the front face of the semiconductor wafer 2 as shown in drawing 5. In each process which manufactures a semiconductor integrated circuit then, it not only removes the foreign matter 1 on a wafer front face, but It is necessary to also remove certainly the foreign matter in the trench hole and Mizouchi whose sizes of the intense portion of a convex, for example, an aspect ratio, are about dozens. \*\*\*\* -- For example, although the particle adhering to the wafer front face has exfoliated as shown in drawing 6 (a) when [ which was washed for 60 minutes using the pure water rinse ] it after self-\*\*, the foreign matter 1 still carried out and remains. Moreover, although a foreign matter 1 is lost in the front face of the semiconductor wafer 2 as shown in drawing 6 (b) when [ which was washed with the pure water rinse by SC-1 for 5 minutes for 5 minutes ] it after self-\*\*, in the trench hole 3, it still carried out and remains.

[0003]

[Problem(s) to be Solved by the Invention] However, the washing method of the conventional semiconductor device mentioned above does not have an effective means to remove the foreign matter in a trench hole completely, and had the trouble that still carried out and a foreign matter remained. This invention was made in order to cancel the above troubles, and it aims at removing the foreign matter which is in the inside of the front face of a semiconductor wafer, a hole, and a slot by the molecular motion of the penetrant remover by the ultrasonic wave.

[0004]

[Means for Solving the Problem] The washing method of the semiconductor device concerning this invention irradiates an ultrasonic wave with a horizontal component and a vertical component to the hole and slot which were formed in the semiconductor wafer, vibrates a liquid molecule, and is washed.

[0005]

[Function] With the help of the energy of an ultrasonic wave, by the molecular motion (size of the same grade as a foreign matter) of a penetrant remover, this invention can remove it completely to the exterior, after taking out the foreign matter in the inside of the front face of a semiconductor wafer, a hole, and a slot from from outside among a hole and a slot.

[0006]

[Example] Drawing 1 is drawing showing one example of the washing method of the semiconductor device concerning this invention, and especially drawing 1 (a) is drawing for the cross-section side elevation, drawing 1 (b), and drawing 1 (c) explaining washing operation in drawing 1 (a). The washing tub into which 4 put the penetrant remover 5 in this drawing, and 6 are the cases where were the ultrasonic wave oscillator which outputs an ultrasonic wave 7, are the case where a ultrasonic wave oscillator 6 is attached, made the anchoring wall surface of the washing tub 4 to have been attached in the wall surface of this washing tub 4, and incline as an example so that an ultrasonic wave 7 may irradiate the front face of the semiconductor wafer 2 at an angle of predetermined as an example, and a ultrasonic wave oscillator 6 is attached.

[0007] Next, the inside of the washing method of the semiconductor device by the above-mentioned composition, especially the trench hole 3 is washed, and operation which removes a foreign matter is explained with reference to drawing 1 (b) and drawing 1 (c). First, if it sees from the front face of the semiconductor wafer 2 with the trench hole 3, an ultrasonic wave 7 can be divided into horizontal component 7a and vertical-component 7b to the trench hole 3, as shown in drawing 1 (b). Therefore, as shown in drawing 1 (c), horizontal component 7a of this ultrasonic wave 7 vibrates the penetrant remover 5 in the trench hole 3 to horizontal direction 8a, makes the foreign matter 1 in a trench 3 exfoliate, and discharges a foreign matter outside the trench hole 3. On the other hand, vertical-component 7b of an ultrasonic wave 7 vibrates the penetrant remover 5 in the trench hole 3 to perpendicular direction 8b, as shown in drawing 1 (c), and it acts so that the foreign matter 1 discharged by the front face of the semiconductor wafer 2 may be kept away from the front face of the semiconductor wafer 2.

[0008] In addition, by making it 20 - about 70 degrees, the degree of setting angle of the ultrasonic wave oscillator 6 to the semiconductor wafer 2 exfoliates efficiently, and can discharge the foreign matter 1 in the trench hole 3. It is [0009] without the inside of a trench 3 and a semiconductor wafer front face. [ at drawing 7 , wash by (SC-1)+ (MS) for 10 minutes, and are the case washed with the pure water rinse for 5 minutes where it after self-\*\*, and ] [ remains of particle ] Drawing 2 is drawing showing other examples of the washing method of the semiconductor device concerning this invention, and especially drawing 2 (a) is drawing for the cross-section side elevation, drawing 2 (b), and drawing 2 (c) explaining washing operation in drawing 2 (a). Set to this drawing. The 1st ultrasonic wave oscillator which outputs the horizontal ultrasonic wave 10 to the trench hole 3 9a-9d, and 11 are the 2nd ultrasonic wave oscillator which outputs the vertical ultrasonic wave 12 to the trench hole 3. In addition, of course, operation which exfoliates and removes the foreign matter 1 in the foreign matter adhering to the front face of the semiconductor wafer 2 and the trench hole 3 is the same as that of operation of drawing 1 .

[0010] Next, the frequency (MHZ) of the ultrasonic wave for removing the foreign matter 1 in the trench hole 3 and the relation of power (W/cm2) are explained with reference to drawing 3 and drawing 4 . first, in order to remove the foreign matter 1 in the trench hole 3 (A) In order to tell energy to the molecular flow 13 of a penetrant remover 5 into the trench hole 3, Ultrasonic wave with oscillating width of face smaller than the path of the trench hole 3 (B) \*\* which a penetrant remover 5 writes by the molecular flow 13 of the penetrant remover 5 of vibrating the foreign matter 1 in the trench hole 3 by the molecular flow 13 of a penetrant remover 5, and making it exfoliate and the trench hole 3 is accelerated. In order to discharge a foreign matter 1 out of the trench hole 3, on the front face of the semiconductor wafer 2 with a perpendicular (level to the trench hole 3) And ultrasonic wave with oscillating width of face of the same grade as a foreign matter 1 (C) \*\* which the penetrant remover 5 in the front face of the semiconductor wafer 2 writes the foreign matter 1 discharged by the front face of the semiconductor wafer 2 by the molecular flow 13 of a penetrant remover 5 is accelerated. Since it keeps away from the front face of the semiconductor wafer 2, it is possible by the ultrasonic wave with oscillating width of face of the same grade as a foreign matter 1 at a level with the front face of the semiconductor wafer 2 (perpendicular to the trench hole 3). Then, sound power of an ultrasonic wave (I:W/cm2) The relation between frequency (f) and the molecular vibration width of face (A:cm) of a penetrant remover 5 can be shown below.

[0011]  $I = \rho C (2\pi f A)^2 / 2$ , however  $\rho$  are the density (g/cm3) (in the case of water, it is 1) of a penetrant remover (5).

$C$  is acoustic velocity (cm/S) (in the case of water, it is  $1.5 \times 10^5$  (cm/S)).

[0012] Frequency of 800kHz from the above-mentioned formula and sound power 7.5 W/cm2 in order to obtain liquid molecular vibration width of face of 0.06 micrometers noting that the 0.06-micrometer foreign matter 1 in the 1-micrometer trench hole 3 of width of face is removed efficiently It is required. And the relation between the frequency in the case of obtaining oscillating width of face of 0.01 micrometers, 0.06 micrometers, and 0.5 micrometers and sound power is shown in drawing 4 . Moreover, it is necessary to add the ultrasonic wave which has a vertical component and a horizontal component for the acoustic energy of the frequency of 100kHz - 10MHz, and 0.01 - 4,000 W/cm2 to the trench hole 3 for removing the foreign matter (0.5 micrometers - 0.01 micrometers) in the 1-micrometer trench hole (3) of width of face to a wafer front face.

[0013]

[Effect of the Invention] As explained to the detail above, according to the washing method of the semiconductor device concerning this invention, there is an effect which exfoliates in the kinetic energy of the liquid by the ultrasonic wave and the liquid flow, and can discharge completely outside the foreign matter adhering to the hole, Mizouchi, and the front face which were formed in the semiconductor wafer.

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[Translation done.]